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Wiley, Rein & Fielding

1776 K Street, N.W.
Washington, D.C. 20006
(202) 719-7000

David E. Hilliard
(202) 719-7058
dhilliard@wrf.com

Fax: (202) 719-7049
www.wrf.com

October 28, 1999

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
445 12th St., S.W.
Washington, DC 20554

Re: Ex Parte Notification
ET Docket No. 98-153
Ultra-Wideband

Dear Ms. Salas:

This is to note that on October 27, 1999, Ralph Petroff, President and Chairman of Time Domain Corporation, met with Chairman William E. Kennard. Mr. Petroff urged the Commission to continue moving forward with its consideration of ultra-wideband technology and to issue a notice of proposed rule making. As an initial application of UWB technology, Mr. Petroff suggested that the Commission consider indoor uses. This is also to note that in advance of his meeting, Mr. Petroff previously provided Chairman Kennard with copies of the attached two articles from *USA Today*.

Should any questions arise concerning this matter, please contact me.

Respectfully,

David E. Hilliard

David E. Hilliard
Counsel for Time Domain Corporation

Enclosure: *USA Today* articles
cc: The Honorable William E. Kennard (w/encl.)

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List ABCDE

Ultra-wideband technology gets stuck in feds' red tape

WASHINGTON — Imagine it's 1971. Mainframe computers rule. Intel has built the first commercial microprocessor. Time to unleash it. See what people might do with it. Some radical, long-haired engineers might create the personal computer.

Start a revolution. Change the world. Now imagine a parallel universe. In this one, computers are regulated by the federal government. Intel can't do anything — can't even test its innovation — without the feds' OK. But the feds aren't sure what to do.

TECHNOLOGY

By Kevin Maney

The microprocessor doesn't fit the regulatory processes that for decades worked for mainframes. The feds worry that the new chips could muck up the existing computer industry and maybe cause data to be lost. Time plods by.

Years even. Intel investors tire of waiting. Intel runs out of cash and can't raise more. The revolution gets delayed. Maybe it doesn't happen. Maybe it happens in Japan.

Silly? You'd be amazed.

Right now, our friends in government are tangling up a technology that could have the impact of the microprocessor.

The technology is called ultra-wideband (UWB) wireless communications. The driving company of UWB — the industry's Intel — is Time Domain of Huntsville, Ala.

UWB is still something of a laboratory science project, but it seems to be a breakthrough in wireless. Instead of using continuous radio waves, UWB sends information on tiny wave pulses. The technology should mean that ever-smaller devices will be able to do vastly more powerful wireless communications and, in fact, do things today's wireless can't do. UWB is to today's cell phones and radar what the microprocessor was to yesterday's mainframes. It could launch another revolution.

At the Ultra-Wideband Conference here last week, Bjoerne Eske Christenson of Germany's Siemens said that if UWB fulfills its promise, "it would penetrate every product in Siemens, as the laser and transistor do now." Others talked of being able to make untethered cable television, which would allow you to move a TV anywhere in the house, regardless of where the cables run. One company is working on UWB underground radar for finding gold. Another talks of using UWB to create motion sensors so cheap and accurate, you could put one in your elderly parent's house, monitor it via the Internet and tell whether Mom or Dad fell.

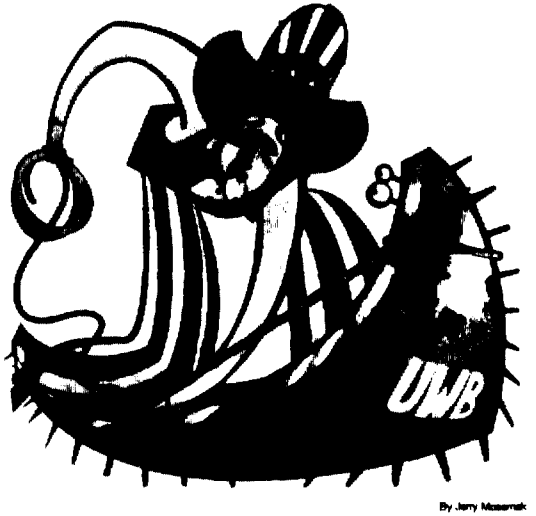
But the UWB market is stalled. The reason became apparent as the conference turned toward government and regulatory speakers.

Wireless communication is regulated. It has to be. There is only so much radio spectrum available for communications. If the federal government — in most cases, the Federal Communications Commission — didn't parcel out spectrum to TV and radio stations, cell phones and so on, the signals would trample each other.

But the regulations and the process for changing them has grown so many layers and so much bureaucracy, it's stultifying. So the panelists fretted over potential problems with UWB interfering with other radio signals — problems that don't seem to exist. They laid out timetables that would unfold slower than a soap opera plot. Julius Knapp of the FCC said the next steps are to analyze information, do more testing and then make a proposed rulemaking, which is not to be confused with an actual rulemaking.

It's about like saying to your wife, "I'm going to make a proposed lawnmowing" — then going in the garage and gazing at the lawnmower before going inside and turning on the football game.

Panelist Bill Hatch, from the FCC, said: "We have to make sure we have the proper regulations blah blah blah to approve or accommodate new technologies blah blah blah when it doesn't fit into the regulatory processes we already have blah blah blah." At least that's what I wrote in my notebook.



By Jerry Mosemak

To her credit, FCC Commissioner Susan Ness got up and criticized government sluggishness, saying it has to learn to move at "Internet speed." But then, when she specifically addressed UWB, she said she'd push for "an initiative within the next few months with the hope of completing a study next year." Next year? For just a study? That's Internet speed? By next year, any Silicon Valley venture capitalist worth his salt will have found, funded and taken public four companies.

Fact is, we don't really know what UWB can do or whether it could mess up existing wireless communication because regulations have prevented much testing and development.

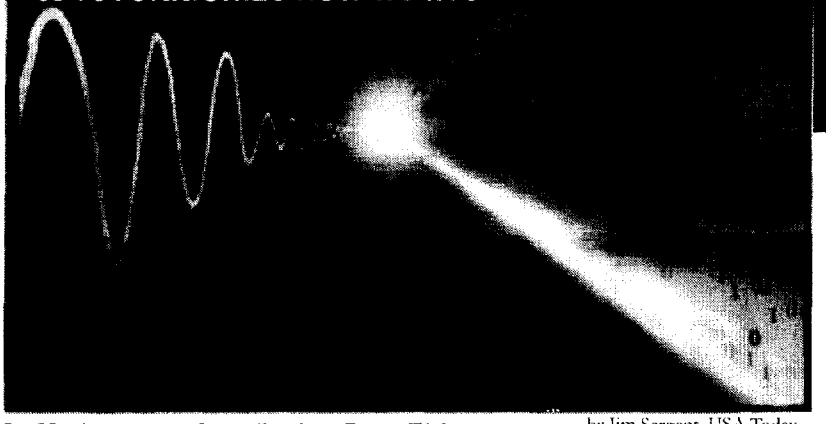
"They should let it rip," said Irv Rappaport of Aurigin Systems. "Then if there's a problem, regulate it."

That would be the Silicon Valley way. If we're going to see microprocessor-style breakthroughs in communication, something's got to change. Former FCC chairman Reed Hundt often said that true success for the FCC would be if it found an effective way to eliminate itself. A whole lot of people at the UWB conference would've given that idea a lusty cheer.

E-mail kmaney@aol.com

Pulsing with promise

New digital technology likely to revolutionize how we live



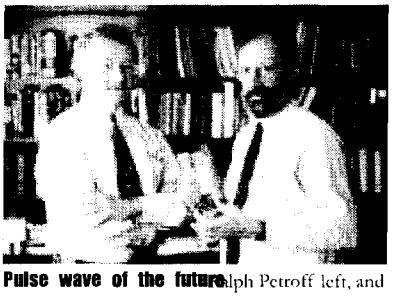
USA TODAY
Money
4/9/99 pages B2 & B3

By Kevin Maney, Contributing: Peter Eisler

by Jim Sergent, USA Today

HUNTSVILLE, Ala. - A little-known company in this city of rocket scientists is about to explode onto the scene with an invention that might be as important as the transistor or electric light bulb.

The company is Time Domain. Its breakthrough is the work of Larry Fullerton, a lone inventor who harks back to the era of Thomas Edison. His invention is a way to transmit information wirelessly, but not using radio waves. Instead, it uses pulses of radio energy, fired out at 10 million to 40 million pulses a second.



Pulse wave of the future. Ralph Petroff left, and Larry Fullerton of Time Domain are working on digital pulse technology.

The potential impact is astounding. If the technology lives up to its promise, it would be like the leap from vacuum tubes to the transistor or from oil lamps to light bulbs, touching every home and workplace. Wireless communicators could get down to the size of a quarter. Radar could become cheap and commonplace. A home radar system could be used for security, detecting movement inside and distinguishing a cat from a man. Already a reality is hand-held radar that police can use to see inside a room before bursting in.

The pulse technology, sometimes also called ultra-wide band (UWB), could launch whole new industries and reorder several existing ones in coming decades.

"This is a technology that's as radical as anything that's come up in recent years," says Paul Turner, a partner at PricewaterhousCoopers who has studied Time Domain and advised the upstart company. Others agree. Representatives from major technology companies have trooped to Huntsville the past few months. "If they can really pull it off in volume, it can be quite huge," says IBM Vice President Ron Soicher who admits to getting goose bumps when he realized the potential.

The technology is digital.. Each of the whizzing pulses is a 1 or 0, so the transmissions are as flexible as a computer, able to handle phone calls, data or video. The pulses can carry information or media as fast as the speediest corporate Internet connection. The pulse technology has other advantages:

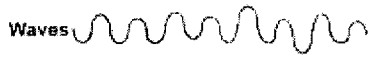
- It could open up capacity for radio communication. Today, there's a wireless traffic jam. Users of radio waves have to operate in their specific, government-granted slices of the increasingly crowded radio spectrum; otherwise, they'd interfere with one another. But it's unlikely the pulses would interfere with each other or with conventional radio waves, so the pulses would open up vast new radio real estate.
- Pulse devices could operate on one-thousandth the power of devices that use radio waves, so a phone could be the size of a wristwatch.
- The pulses in Time Domain's technology are read by timing the incoming pulses to 10 picoseconds - 10 trillionths of a second. Any pulse device could tell how long it takes for a signal to get to it, which makes it able to sense objects and measure their position more accurately than conventional radar. Radar could be a mass-market product for homes or cars.
- The pulses are timed according to a complex code shared only by the sender and the intended receiver.

The chance of anyone who doesn't have the code intercepting the signal is near zero. That means pulse communications should be the most secure way ever to transmit wirelessly – of major interest to the military.

Fullerton started working on the technology in 1976 and got his first patent for it in 1987. But the technology was crude, Fullerton didn't have the money to push it, and the world wasn't paying attention. All that is

How pulse technology works

Time Domain founder Larry Fullerton has come up with a new way to send and receive signals over the air. For the past 100 years the only way to wirelessly transmit signals - voice, music, TV, data - has been by radio waves.



Fullerton's digital pulse technology transmits pulses of energy instead of waves. Each pulse represents a 1 or a 0, the digital language of computers. Ten million to 40 million pulses are sent per second, fast enough to carry voices, Web pages and video.

The benefits

1 Pulses work around crowded radio spectrum.

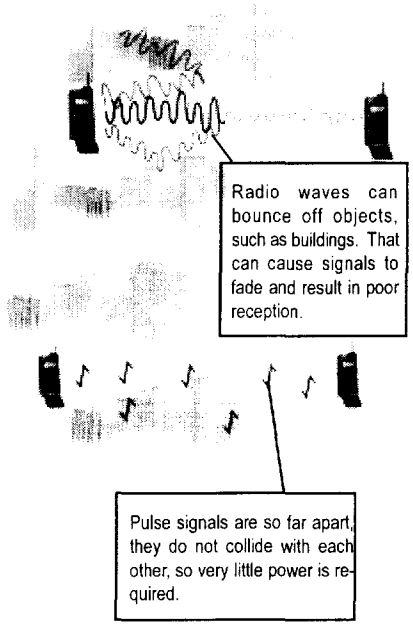
There are limits on how much information waves can carry and how much space these is on the radio spectrum. As things like cell phones and satellites proliferate, the radio spectrum is becoming scarce.

The pulses have no frequency – no slot on the radio dial. Instead, the pulses are spread across the radio spectrum.

Because pulse technology doesn't eat up spectrum, it could unlock the traffic jam.

The downside is that in doing so, it might threaten the entities that have spent billions of dollars to buy rights to chunks of radio spectrum.

3 Less battery and transmitter power is needed

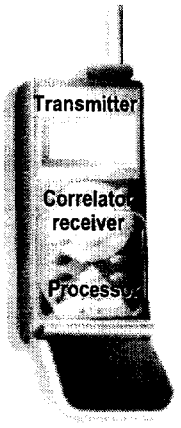


Radio waves can bounce off objects, such as buildings. That can cause signals to fade and result in poor reception.

Pulse signals are so far apart, they do not collide with each other, so very little power is required.

The new phone

A cell phone built with Time Domain's technology would have three pieces: a transmitter, a correlating receiver and a processor. Eventually, each would be on a single computer chip. They'd all have to work together to make the phone work. What each piece does:



Transmitter:
Sends 10 million to 40 million pulses per second. The intervals are staggered in any of 30,000 different spots within every 100 feet. The intervals vary according to a code stored in the device. The transmitter operates on the same digital principle as a computer, creating all information out of 1's and 0's.

Correlating receiver:
Once the correlating receiver knows the code that governs the intervals of the pulses, it listens at those intervals and figures out whether each pulse is a 1 or 0.

Processor:
The processor acts like a traditional computer chip. It assembles the 1's and 0's into information, then turns it into sound, video, or data on a screen.

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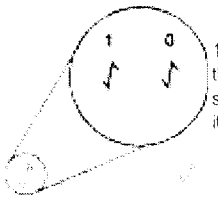


If a pulse goes out 125 picoseconds earlier than the exact spot prescribed by the code, then it's a 1. If it goes out 125 picoseconds later, it's a 0.

If one device send out a signal, how does another find and listen to it? The pulses (each 6 inches long) leave a device at precise intervals in time, measured to within 10 trillionths of a second, or 10 picoseconds. There is one pulse for every 100 feet, and that pulse can be in one of 30,000 positions within that space. For one device to listen to another they must share a code that tells the listening device which positions to listen to in what order. The listening device then assembles the pulses into a voice or data picture.

Receiver knows which pulses to receive by their sequence in time, which is coded into the device.

This timed pulse system has a number of amazing characteristics.

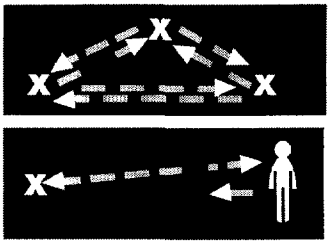
One is security. Because of the astounding number of possible combinations of positions, Time Domain says, there is no way to tap into this kind of communication unless you have the code.

Another by-product of the huge number of combinations is that 2,000 to 20,000 people could use pulsed cell phones in the same square block and probably never interfere with one another or overload the cellular system. A conventional cell system can only handle about 400 users in one small area.

Other uses of the technology

Geographic positioning: Because of the precise timing of outgoing and incoming pulses, a device can measure the time it takes for a pulse to get to it or bounce back from it. In doing so, the device can tell how far away the sender of a pulse is or how far away an object is. The accuracy is within less than an inch, compared with 5 feet for global positioning satellite, or GPS, systems. That accuracy could enable farmers to use robotic equipment.

Radar: Using the same technique, the device can act like radar. But unlike radio-based radar, which gets confused indoors because of waves bouncing around, pulsed radar works indoors, through walls and underground. Because pulsed radar requires little power, pocket radar is possible.



changing in a big way.

Band of believers grows

In Time Domain's offices are prototypes of a wireless phone that can measure the distance to the other party, cameras that can transmit video wirelessly to a computer screen, and radar that works indoors and through walls, which conventional radar can't do. The prototypes are hand-built and clunky. "We haven't built a lot of things yet, so we don't know how much reality will intrude on theory," CEO Ralph Petroff says. "But our guys say they can do it."

The list of believers is growing. The Federal Emergency Management Agency has contacted Time Domain because its radar technology could pinpoint victims beneath an earthquake's rubble. "This technology has the potential to reduce casualties among civilians and rescue workers alike," says a comment FEMA filed with the Federal Communications Commission.

The Marines have been looking at Time Domain prototypes because they'd like a walkie-talkie that's not only undetectable but can tell a Marine the location of all the other members of his unit. The Immigration and Naturalization Service is doing a pilot project with Time Domain. It's interested in ways the technology could be used along the border. Put a wireless, low-power camera in a cactus, and it could transmit video back to INS agents; no need to string telltale wires across the desert.

A few pulse technology products are ready for a broader market, pending FCC approval. Time Domain has made hand-held radar that police could use to see inside a room before bursting in. A couple of small companies are making pulse radar devices for measuring liquid in steel storage tanks. A handful of research labs, such as the Ultra Lab at the University of Southern California, are experimenting with pulses.

Mass-market products are still years away. Cell phones, Petroff predicts, are a decade off. "There are still three to four iterations of design that have to go on before we really know if it all looks good," says Robert Scholtz of Ultra Lab. "Still, no one has disproved its potential."

Recent developments are giving the technology a head of steam.

Until about a year ago, Fullerton's invention was, as he says, "a science project." It worked only in theory or in awkward and costly lab experiments. Then IBM came up with a new way to make a chip using the material silicon germanium. That chip turned out to be perfect for measuring time to the picosecond and controlling release of the pulses – at low cost. Working with IBM's Soicher, Time Domain became a test project for the chip. "It's been a perfect match," says Alan Petroff, brother of Ralph and head of Time Domain's engineering work. "We wouldn't be doing this now if not for that."

Another development has to do with money, and lots of it. In 1995, Time Domain was an 11-person Huntsville company that struggled to make payroll. Since then, the Petroff family, which previously had built a multinational environmental engineering company, invested $3 million and took over management. (Fullerton, who admits he's an inventor, not a manager, still owns more than 20% of Time Domain and is the company's most valuable asset.) The Petroffs have raised an additional $17 million from dozens of investors, many from Silicon Valley.

The money has enabled Time Domain to build prototypes, hire engineers, do some marketing and get to critical mass. "They now have a backbone of credibility," says Heidi Roizen, a powerful Silicon Valley player who has advised Time Domain and introduced it to the computer and Internet crowd. "They have proved their concept, and they've gotten out to meetings" and people are taking them seriously, she says.

New industries, not old

Events this week are helping. Today, the House Science Committee is releasing a report that could clear up confusion about the technology. For most of the 1990s, Fullerton has been in a patent dispute with the federal Lawrence Livermore National Laboratory. He alleges that Livermore tried to swipe his pulse technology by applying for a similar patent in 1993. In a preliminary ruling, the Patent Office has thrown out Livermore's key patent claims, citing Fullerton as the true inventor. In today's report, the House Science Committee will castigate Livermore for its behavior and say Fullerton is the inventor.

Tuesday, Ralph Petroff gave a brief report to FCC commissioners at their invitation. It was a sign that another obstacle might begin to move. No one can even test a pulse-transmitting product without approval from the FCC, and so far, the FCC has granted none. In fact, the agency has been very wary of the technology, which doesn't fit with anything it has experienced before.

The technology has come far enough to let Time Domain and others begin thinking of ways Fullerton's invention could change the world.

Certainly the technology could have a profound – maybe devastating – effect on several existing industries. Companies in TV, radio and telecommunications have spent billions of dollars buying rights to slots on the radio spectrum and billions more developing products to use on those slots. It might take decades, but Time Domain's technology could make those rights far less valuable and the products obsolete. "This is really a paradigm buster," says Bennett Kobb, author of *SpectrumGuide*, which keeps tabs on radio spectrum.

Time Domain, however, pointedly says it's not trying to go at existing industries head-on. For one, it would rather have companies like Motorola and AT&T as allies, not enemies. "Time Domain has to try to get into the market in a manner that's

as non-threatening as possible to other stakeholders, who will try to protect their turf from any kind of alien thinking," Kobb says.

Second, Ralph Petroff says he's interested in spawning new industries, not scrambling old ones. Time Domain wants to use the Intel business model. It would make the internal chip set that could power any product: Time Domain inside. Entrepreneurs and big companies would come up with the innovative products based on the technology. Just as no one could imagine how the transistor would be used when William Shockley fathered its invention in 1947, no one knows how pulse technology might be used.

But Petroff has some intriguing ideas. For instance, the technology's ability to measure a position is so good, it can be accurate to within less than an inch. That would allow for what Petroff calls precision farming. Put pulse technology on a tractor, and the vehicle could plow a field by itself. Or the positioning aspects might allow for the creation of a self-guided bricklaying machine.

Time Domain technology could be perfect for the blossoming industry of home computer networking. The single biggest obstacle to home networking is the wiring: Who wants to string another set of wires to every computer, printer, TV and other device around the house? With pulse technology, you might be able to put a box on the side of the house that would be powerful enough to transmit TV, the Internet and phone calls to any device inside.

Tinkerer solves puzzle

The credit for all this rests with Fullerton. Inventors like him seemed to have died with the complexity of the modern age: one person, tinkering in a private lab, creating something entirely new.

"He is a brilliant inventor, and he does have a lot of the sort of Edisonian quality," says Turner of PricewaterhouseCoopers.

Fullerton is 48, married, with two grown children. He's had a lab since he was 7. His father was in the military, and they moved a lot. His labs went with family. At 13, he was introduced to amateur radio by a neighbor at McChord Air Force Base in Tacoma, Wash., and was fascinated. He went to the University of Arkansas in Fayetteville, Ark, where a favorite professor, Leonard Forbes, told the class one-day of a theory of pulsed communication. Research on the theory had been going on for years. But, Forbes said, pulses could never be transmitted.

"I couldn't think of a reason it wouldn't work," Fullerton says. And if it worked, he realized, its potential would be awesome.

He kept experimenting in his home lab until one day he used pulses to transmit music-a tape of the album Chicago III- from his workbench to a hand-held receiver in his yard. "When it worked, I got kind of a spooky feelings," he says.

He got jobs with big companies-Texas Instruments, ITT, CSC- and started a small, not-very-successful one. He kept tinkering. CSC brought him to Huntsville, where he looked up a patent attorney and won his first patent. He now has 10 U.S. patents for pulse technology and 32 abroad.

Lanky and bearded, Fullerton comes across as painfully shy, but underneath he is steely and wily. He met Alan Petroff in the 1980s. Peter Petroff had some from Bulgaria to work with Huntsville's rocket scientists building the U.S. space program in the 1960s. He then invented the digital watch, founding Pulsar in 1969, and later built ADS Environmental Services with his three sons, Ralph, Alan and mark.

By 1995, Fullerton lured in Alan Petroff, who took a $25,000 salary just to get in. A year later, the rest of the Petroffs joined him. "We had all planned to retire," says Petroff, now 44.

The Petroffs brought money and management. Without them, Fullerton's invention might have died.

Hurdles to history books

Time Domain still faces obstacles a plenty. It needs to build more prototypes to prove without a doubt that the technology works as advertised. So far, the company has encountered no serious glitches in its march to do so. Time Domain also needs to carefully choose partners – staying wary, as Roizen advises, of big companies that might bury the technology amid bureaucracy and infighting.

The FCC is a huge obstacle. Time Domain has been trying to prove that pulse communications would not interfere with other signals on the radio spectrum, but Scholtz says that's "still an open question." The FCC has not yet granted Time Domain waiver to test products. Commercial products will require a major rule change that can take to two years. But the FCC is listening.

I hope (that it would be approved)," says John Reed of the FCC's technical rules branch. "There are quite a few benefits that could be obtained from it."

And since Time Domain plans on building innards, not products, "it must ignite the entrepreneurial community so people will build these things," Roizen says.

But the technology seems to be on the right path.

"Until a few years ago, I'd wake up in the middle of the night and say, 'What am I doing?'" Fullerton says. "But the way I feel now, there's no stopping it."

Contributing: Peter Eisler